**From:** **Angela McFadden/R3/USEPA/US**
**Sent:** 1/19/2012 9:01:29 AM

**To:** Marcos Aquino/R3/USEPA/US
**CC:**
**Subject:** Fw: From TEBOW to TENORM

----- Forwarded by Angela McFadden/R3/USEPA/US on 01/19/2012 09:01 AM -----

From: **Ex. 6 - Personal Privacy**
To: undisclosed recipients: ;
Date: 01/19/2012 08:55 AM
Subject: From TEBOW to TENORM

Here's a new, professional-grade video about Dimock worth your 10-minutes to watch. The video features **Julie Sautner** of **Dimock** who tells how her well water went bad the month after Cabot began drilling 976 feet away, and what has happened since then.

http://www.youtube.com/watch?v=vBcytoCLWgo

---

**Corrections/Amplifications**:
For those who were paying attention (..and actually read my emails) there was a typo in last Saturday's email about the radiation levels at well 6H in our county park. I mistakenly listed Ra 226 twice, whereas the second entry should have been **Ra 228**. The corrected report is shown below:

**Cross Creek County Park 6H Permit #125-22830**
Date of Samples 4/1/2009 & 6/29/2009
Radium 226 in Water (pCi/L) 1140
**Radium 228 in Water (pCi/L) 1120**
Total Radium in Water (pCi/L) 2260
Uranium 238 in Water (pCi/L) 90
Benzene 880 ppb

The Railroad Commission of Texas offers this summary on naturally occurring radioactive materials (NORM).....

## NORM in the Oil and Gas Field

NORM encountered in oil and gas exploration, development and production operations originates in subsurface formations, which may contain radioactive materials such as uranium and thorium and their daughter products, radium 226 and radium 228. **NORM can be brought to the surface in the formation water that is produced in conjunction with oil and gas**. NORM in these produced waters typically consists of the radionuclides, radium 226 and 228. In addition, radon gas, a radium daughter, may be found in produced natural gas.

Because the levels are typically so low, NORM in produced waters and natural gas is not a problem in Texas unless it becomes concentrated in some manner. Through temperature and pressure changes that occur in the course of oil and gas production operations, radium 226 and 228 found in produced waters may co-precipitate with barium sulfate scale in well tubulars and surface equipment. Concentrations of radium 226 and 228 may also occur in sludge that accumulates in oilfield pits and tanks. These solids become sources of oil and gas NORM waste.

In gas processing activities, NORM generally occurs as radon gas in the natural gas stream. Radon decays to Lead-210,

then to Bismuth-210, Polonium-210, and finally to stable Lead-206. **Radon decay elements occur as a film on the inner surface of inlet lines, treating units, pumps, and valves principally associated with propylene, ethane, and propane processing streams**.

Workers employed in the area of cutting and reaming oilfield pipe, removing solids from tanks and pits, and refurbishing gas processing equipment may be exposed to particles containing levels of alpha-emitting radionuclides that could pose health risks if inhaled or ingested.
http://www.rrc.state.tx.us/environmental/publications/norm/index.php

1994 piece from Canada about radiation in Propane:

## Potential for elevated Radiation levels in Propane

In November of 1992 the National Energy Board received an incident report from Petroleum Transmission Company Ltd. with respect to elevated, but not unsafe, levels of radiation detected in propane. The origin of this radiation was determined to be natural occurring radioactive materials ("NORM") which occur as a result of radon, a radioactive gas, **selectively dissolving in the propane fraction of natural gas liquids**. Upon radioactive decay, radon gas is converted into radon progeny particulates.

These particulates can accumulate along internal surfaces of tubulars, filters and other equipment surfaces such as those **found within extraction facilities** or along the propane transmission pipelines. The particular radioactive species identified were radon 222 and radon progeny which are part of the natural uranium (U-238) decay series.

Alberta Occupational Health and Safety ("AOHS"), Radiation Health Branch conducted a further investigation and has since issued a report on its findings. Although the AOHS report indicates that no significant public health risk due to radon or radon progeny in propane product was found, **AOHS recommends that the petroleum industry develop a quality assurance program to qualitatively measure the concentration of radon in propane prior to release to the open market**. *

The report also indicates that workers are only receiving radiation exposures approaching the safe maximum annual limit when they come in direct contact with equipment and when contact is maintained for a complete work day. Survey measurements indicate that radon progeny are accumulating in various equipment.

Although worker proximity at this time does not currently pose a significant health risk, the continued build-up of radon progeny in on-line equipment could change the status quo when equipment is taken off-line for servicing or disposal. Removal of metal housings or machining of contaminated internal surfaces could present an unacceptable level of worker exposure either externally due to radiation emission from radon progeny or internally due to the possible inhalation of these particulates by workers not following acceptable contamination control procedures. Therefore, the report indicates that an **on-going radiation monitoring program is a prudent option to consider by all companies with facilities having similar equipment in propane service**.

http://www.neb-one.gc.ca/clf-nsi/rsftyndthnvrnmnt/sfty/sftydvsr/1994/nbs199401-eng.pdf

The EPA throws in the term **TENORM** here:
The geologic formations that contain oil and gas deposits also contain naturally-occurring radionuclides, which are referred to as "NORM" (Naturally-Occurring Radioactive Materials):
- uranium (and its decay products)
- thorium (and decay products)
- radium (and decay products)
- lead-210

Geologists have recognized their presence since the early 1930s and use it as a method for finding deposits (Ma87). Much of the petroleum in the earth's crust was created at the site of ancients seas by the decay of sea life. As a result, petroleum deposits often occur in aquifers containing brine (salt water). Radionuclides, along with other minerals that are dissolved in the brine, precipitate (separate and settle) out forming various wastes at the surface:
- mineral scales inside pipes
- sludges
- contaminated equipment or components
- produced waters.

Because the extraction process concentrates the naturally occurring radionuclides and exposes them to the surface environment and human contact, these wastes are classified as TENORM.
TENORM contamination levels in equipment varied widely among types of equipment and geographic region. The geographic areas with the highest equipment readings were northern Texas and the gulf coast crescent from southern

Louisiana and Mississippi to the Florida panhandle. Very low levels of TENORM were found in California, Utah, Wyoming, Colorado, and northern Kansas.

According to an API industry-wide survey, approximately 64 percent of the gas producing equipment and 57 percent of the oil production equipment showed radioactivity at or near background levels. **TENORM radioactivity levels tend to be highest in water handling equipment**. Average exposure levels for this equipment were between 30 to 40 micro Roentgens per hour (µR/hr), which is about 5 times background. **Gas processing equipment with the highest levels include the reflux pumps, propane pumps and tanks, other pumps, and product lines**. Average radiation levels for this equipment as between 30 to 70 µR/hr. Exposures from some oil production and gas processing equipment exceeded 1 mR/hr.

Gas plant processing equipment is generally contaminated on the surface by lead-210 (Pb-210). However, TENORM may also accumulate in gas plant equipment from radon (Rn-222) gas decay. Radon gas is highly mobile. It originates in underground formations and dissolves in the organic petroleum areas of the gas plant. **It concentrates mainly in the more volatile propane and ethane fractions of the gas**.

Gas plant scales differ from oil production scales, typically consisting of radon decay products which accumulate on the interior surfaces of plant equipment. Radon itself decays quickly, (its half-life is 3.8 days). As a result, the only radionuclides that affect disposal are the radon decay products polonium-210 (Po-210) and lead-210. Polonium-210 is an alpha emitter with a half-life of 140 days. Pb-210 is a weak beta and gamma emitter with a half-life of 22 years.
http://www.epa.gov/rpdweb00/tenorm/oilandgas.html#residentsoffice

Also, the day after I sent the 'Glow in the Dark' email, someone sent the PDF you find attached. Well worth reading this 14-page report, **Radon in Natural Gas from Marcellus Shale**, if the topic of radiation, radon and NORM is of interest to you.

Bob